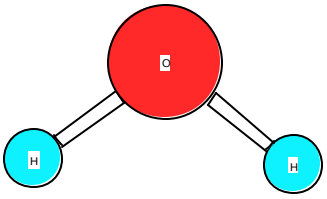
Chemistry 361B **NAME____KEY_____**
Spring 2002
Quiz 3
40 points

This is a closed book quiz, no notes allowed. You will have twenty minutes to answer the following questions.

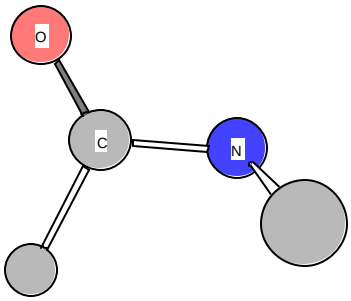
1. (10 points) Water shows a net dipole moment of 1.82D, because the bond angle is not 180°, and the two O-H dipoles fail to cancel. Assuming that the H-O-H bond angle is 105°, determine the bond dipole moment for O-H.



1.82D is the total dipole moment. This is equal vectorially to the component of the bond dipoles in the direction of the dipole moment.

Mathematically, 1.82 = 2(μ O-H)cos(105/2) => 1.49D

2. (15 points) Explain the following:



(a) The peptide bond is flat.

The p_z orbitals on O, C and N overlap to form a delocalized π system of MOs. The partial double bond character restricts the rotation about the C-N bond and locks the atoms in the same plane. See pp. 644-645 of your text.

(b) A solution of $FeCl_3$ is yellow, whereas a solution of $FeCl_2$ is brown.

This is problem 15.45 in your textbook. Fe^{3+} has a d^5 electron configuration. Fe^{2+} is d^6. Five d-orbitals are occupied by unpaired electrons in the first case. A transition requires a change in electron spin. The transition in the d^6 configuration does not. This transition has a higher probability of occurring, so the color is more intense (brown).

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(c) Diethyl ether $C_2H_5OC_2H_5$ has a boiling point of 34.5°, whereas 1-butanol C_4H_9OH, with the same number and type of atoms, has a boiling point of 117°.

This is problem 16.13 in your text. Butanol can make intermolecular hydrogen bonds. Greater intermolecular forces result in a higher boiling point.

3. (15 points) Acetylene C_2H_2 has a tendency to lose two protons (H+) to form the carbide ion C_2^{2-}, which is present in a number of ionic compounds.

(a) Describe the bonding in C_2^{2-} in terms of MO theory. Compare the bond order, bond length and dissociation energy to C_2.

This is problem 15.19 in your text. Table 15.3 has the electron configuration for C_2, which has a bond order of two. C_2^{2-} is isoelectronic with N_2, and has a bond order of three. Thus, the bond in C_2^{2-} is shorter, and the dissociation energy is larger (more stable).

(b) Give the electron configuration for C_2^{2-} and give its molecular term symbol (for this you should have looked at the handout!).

The electron configuration is $KK(\sigma_{2s})^2(\sigma_{2s}^*)^2(\pi_x)^2(\pi_y)^2(\sigma_{2p})^2$ using the energy level diagram in your book on p. 637.

Because all the electrons are paired, the spin multiplicity is 2(0) + 1 = 1. All the orbitals are filled, so $\Lambda = 0$. Therefore, the electronic term is $^1\Sigma$.